April 21, 2005

Project No. 1010.02

Ms. Stephanie Sibbett
BOEING REALTY CORPORATION
4900 East Conant Street
Building 1
Long Beach, California 90808

Technical Memorandum
Capture Zone Analysis in the B-Sand and C-Sand
Former Boeing C-6 Facility
Los Angeles, California

Dear Ms. Sibbett:

This technical memorandum presents a capture zone analysis for proposed hydraulic control options at the Boeing Realty Corporation's (BRC's) former C-6 Facility (the site) in Los Angeles, California. The overall objective is to determine the placement for proposed ground water extraction wells at the site for hydraulic control of chemical constituents in ground water beneath the site. The site location is shown in Figure 1 and a plan of the site is presented in Figure 2. Background information and capture zone modeling simulations are presented in the following sections.

BACKGROUND INFORMATION

Rubicon Engineering Inc. (Rubicon) is currently conducting a feasibility evaluation for various remediation options to address chemical constituents in ground water beneath the site. Several water bearing zones have been identified beneath the site including the Middle Bellflower B-Sand, (MBFB or B-Sand), Middle Bellflower C-Sand (MBFC or C-Sand), and the Gage Aquifer (Haley & Aldrich, 2002). Several of the options being considered for each of these water bearing zones in the feasibility investigation include a hydraulic control component, or ground water extraction. The merits of the ground water extraction include containment of ground water in areas of highest concentrations of chemical constituents, mass removal of those chemicals, and enhanced circulation for options which include injection of bio-amendments. To meet these goals, a capture zone analysis was performed to determine the placement of ground water extraction wells.

APPROACH

The capture zone analysis was performed using the analytical code RESSQ (Javandel, et al., 1984). RESSQ was used to estimate the zone of capture associated with the simulated ground water extraction in the B-Sand and C-Sand. RESSQ calculates the streamline pattern created by the regional hydraulic gradient and ground water extraction. The analytical model assumes that

the regional flow field is uniform and the aquifer is homogeneous, isotropic, confined, and of uniform thickness. Separate model simulations were performed for the B-Sand and C-Sand. For each simulation, it was assumed that no leakage occurred from the less-permeable overlying and underlying formations.

B-SAND CAPTURE ZONE ANALYIS

The model input parameters for the B-Sand simulation are summarized in Table 1. The resulting streamline pattern is presented in Figure 3. A hydraulic conductivity of 20 ft/day was used for the model simulation (CH2M Hill, 2004). Previous investigations have shown the saturated thickness of the B-Sand to range between 25 and 30 feet below ground surface (Haley & Aldrich, 2002) An average saturated thickness of 27.5 feet was used as input to the model. Input values for the regional ground water flow direction and gradient were based on reported values during the 2004 ground water monitoring (Haley & Aldrich, 2004). Specifically, a southerly regional flow direction with a hydraulic gradient of 0.001 was used in the model. Assuming a porosity of 0.3, the ground water flow seepage velocity was calculated as 24.3 feet per year.

A total of eight proposed ground water extraction wells were used in the model simulation. The locations of these wells are shown in Figure 3. Figure 3 also shows a generalization of two separate "source areas" within the B-Sand which contain trichloroethene (TCE) at concentrations exceeding 5,000 ug/L. One source area is in the former Building 2 area while the second is predominantly within Lot 8. Four of the proposed wells are located in Lot 8 and four are located in the former Building 2 area. The simulated extraction rate for each of the eight wells was 3 gallons per minute (gpm). This extraction rate is based on the sustainable B-Sand injection rates that have been observed during recent bio-amendment pilot tests.

The streamline patterns shown in Figure 3 show the zone of capture after one and five years of extraction. The capture zone indicates that all areas containing TCE above 5,000 ug/L will be contained. Assuming an average concentration of 5,000 ug/L in the extracted ground water, the rate of TCE mass removal for a total extraction rate of 24 gpm from the B-Sand would be 1.4 pounds per day.

C-SAND CAPTURE ZONE ANALYIS

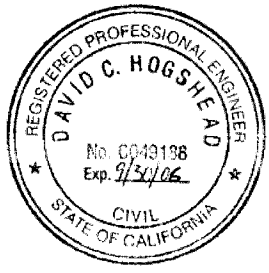
The model input parameters for the C-Sand simulation are summarized in Table 1 and the resulting streamline pattern is presented in Figure 4. A hydraulic conductivity of 145 ft/day was used for the model simulation (CH2M Hill, 2004). Previous investigations have shown the saturated thickness of the B-Sand to range between 13 and 21 feet below ground surface (Haley & Aldrich, 2002). An average saturated thickness of 17 feet was used as input to the model. Input values for the regional ground water flow direction and gradient were based on water levels measured during March 2004. Specifically, a southwesterly regional flow direction with a hydraulic gradient of 0.0010 was used in the model. Assuming a porosity of 0.3, the ground water flow seepage velocity was calculated as 176 feet per year.

A total of six proposed C-Sand ground water extraction wells were used in the model simulation. The locations of these wells are shown in Figure 4. Figure 4 also shows a generalization of two separate "source areas" within the C-Sand which contain trichloroethene (TCE) at concentrations exceeding 1,000 ug/L. One source area is in the former Building 2 area while the second is within Lot 8. Three of the proposed wells are located in Lot 8 and three are located in the former Building 2 area. The simulated extraction rate for each of the eight wells was 10 gallons per minute (gpm). This extraction rate is assumed to be sustainable based on the thickness and hydraulic conductivity within the C-Sand.

The streamline patterns shown in Figure 4 show the zone of capture after six months, one year, and two years of extraction. The capture zone indicates that all areas containing TCE above 1,000 ug/L will be contained. Assuming an average concentration of 1,000 ug/L in the extracted ground water, the rate of TCE mass removal for a total extraction rate of 60 gpm from the B-Sand would be 0.7 pounds per day.

Respectfully Submitted,

RUBICON ENGINEERING CORPORATION



David C Hogshead

David C. Hogshead, P.E.
Senior Engineer

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Haley & Aldrich, Inc., April 27, 2004, *Groundwater Monitoring – Annual Event, March 2004, Boeing Realty Corporation, Former Boeing C-6 Facility, Los Angeles California*, prepared for Boeing Realty Corporation, 4900 Conant Street, Long Beach, California.

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Tables

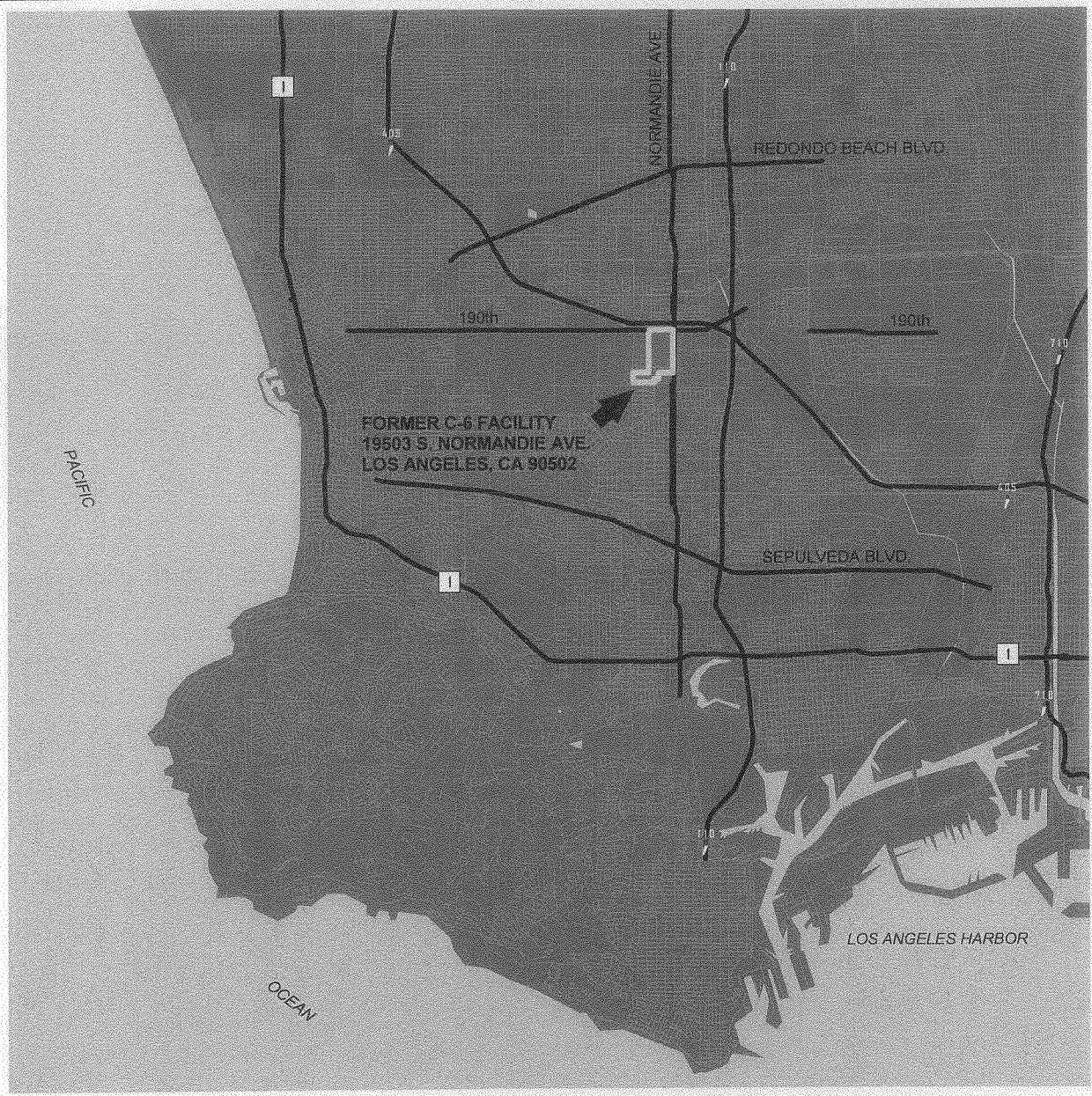
TABLE 1

CAPTURE ZONE INPUT PARAMETERS

Parameter	Symbol	Value	Units	Reference
B-SAND				
Regional Flow Hydraulic Gradien	i	0.0010		Haley & Aldrich, 2004
Regional Flow Direction	α	South		Haley & Aldrich, 2004
Aquifer Thickness	b	27.5	feet	Haley & Aldrich, 2002
Hydraulic Conductivity	k	20	ft/day	CH2M Hill, 2004
Porosity	η	0.3		Assumed
Seepage Velocity	v_s	24.3	feet/yr	Calculated(1)
Number of wells		8		
Extraction rate per well		3	gpm	
Total extraction rate		24	gpm	
C-SAND				
Regional Flow Hydraulic Gradien	i	0.0010		March 2004 water levels
Regional Flow Direction	α	S17°W		Haley & Aldrich, 2004
Aquifer Thickness	b	17	feet	Haley & Aldrich, 2002
Hydraulic Conductivity	k	145	ft/day	CH2M Hill, 2004
Porosity	η	0.3		Assumed
Seepage Velocity	v_s	176	feet/yr	Calculated
Number of wells		6		
Extraction rate per well		10	gpm	
Total extraction rate		60	gpm	

Notes: 1) Seepage velocity calculated as $v_s = ki/\eta$

Figures



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EXPLANATION

BOEING REALTY CORPORATION:
FORMER C-6 FACILITY

REFERENCE:
Base map downloaded from 'Tiger File' data website hosted by ESRI.

0 1 2 Miles

APPROXIMATE HORIZONTAL SCALE

FIGURE 1

SITE LOCATION MAP

FORMER C-6 FACILITY
LOS ANGELES, CALIFORNIA

RUBICON
ENGINEERING

BOE-C6-0140496

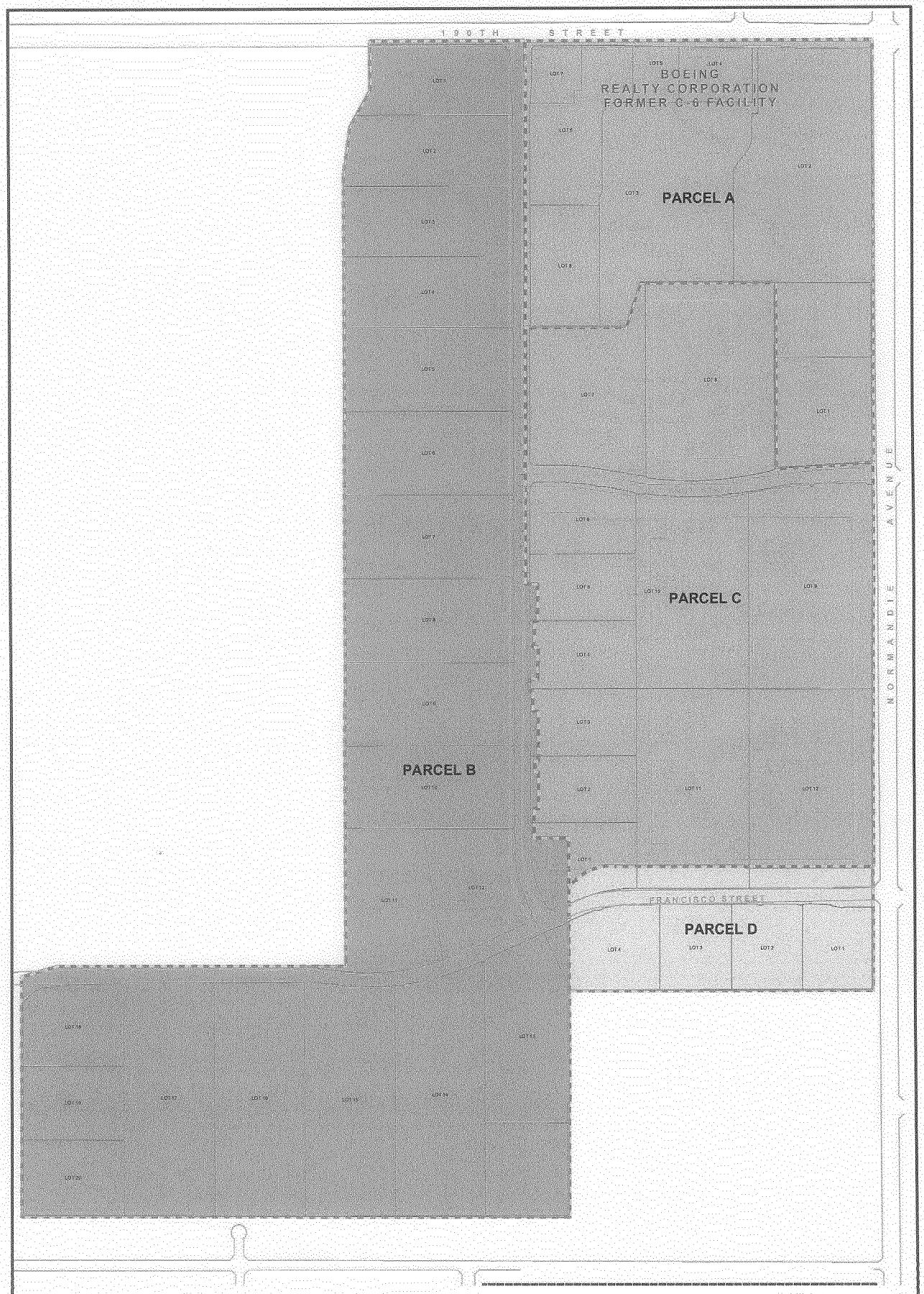

FIGURE 2

SITE PLAN

FORMER C-6 FACILITY
LOS ANGELES, CALIFORNIA

RUBICON
ENGINEERING

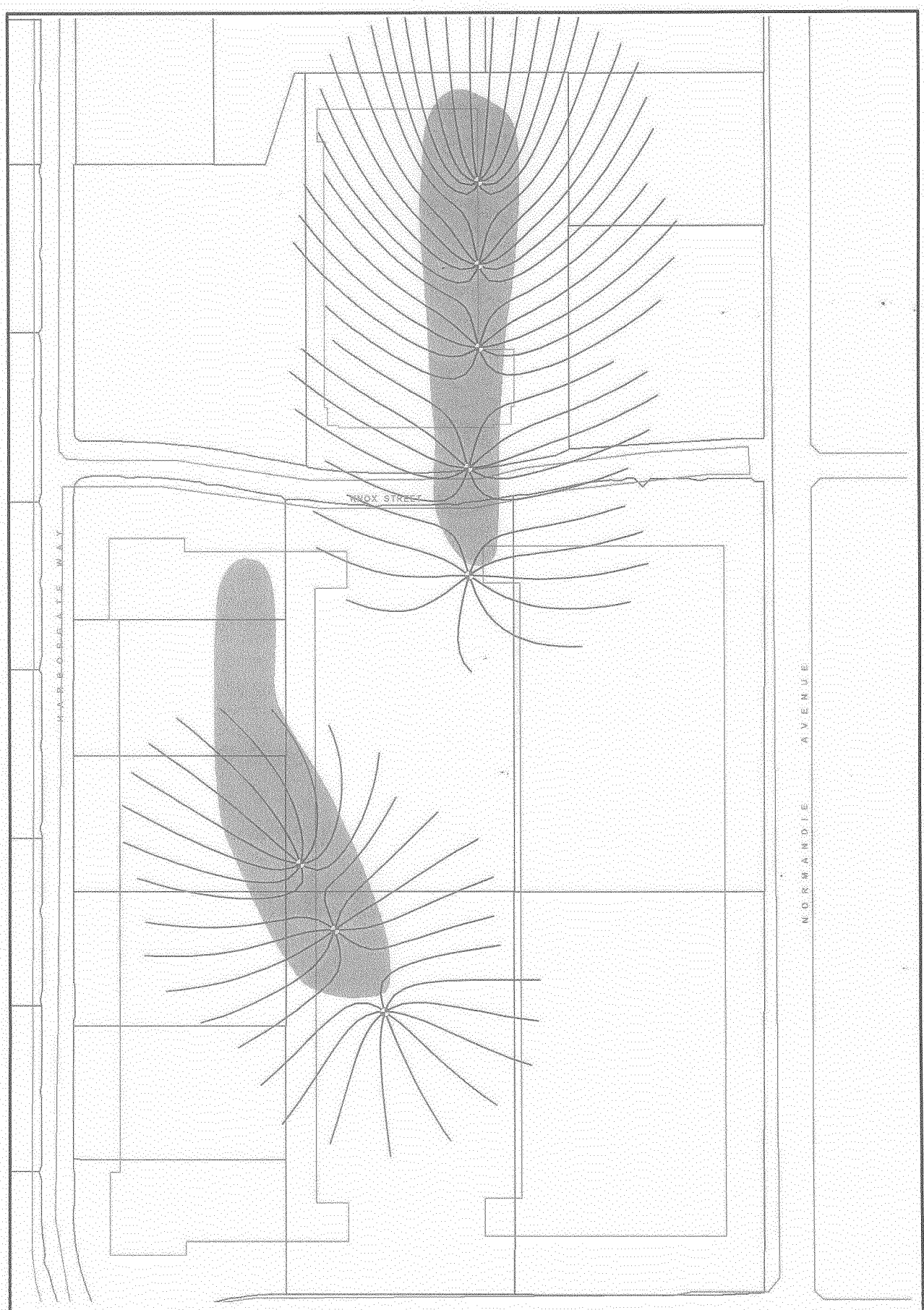

FIGURE 3

CAPTURE ZONE ANALYSIS
B-SAND

FORMER C-6 FACILITY
LOS ANGELES, CALIFORNIA

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FIGURE 4

CAPTURE ZONE ANALYSIS
C-SAND

FORMER C-6 FACILITY
LOS ANGELES, CALIFORNIA

RUBICON
ENGINEERING